Ornithology from the flatlands

Piersma, Theun

Ornithology from the flatlands

CONTRIBUTING TO LARGER INTELLECTUAL FRAMEWORKS

This summer, the University of Extremadura in Badajoz, Spain, hosted the 10th European Ornithological Congress. Such a conference, obviously, is exciting socially. It can also help reveal some of the scientific trends to which we should be paying attention. Two things – one encouraging and the other a cause for concern – struck me (and note that I know that I am as biased as anyone). I was excited by the obvious and enormous growth of migration studies, studies that now make use of ever more sophisticated tracking devices to map movements of individual birds of ever smaller size over ever greater spatial and temporal scales. It is amazing how we are in the process of discovering many new patterns, how many fresh secrets from the bird world are being laid bare. As I will emphasize below, these new findings on birds adjusting to a rapidly changing world can contribute importantly to the current discussions of the nature of evolution.

At the same time, I was amazed, and perhaps a little frustrated, at how few attempts I saw to bring fresh and deep discoveries to bear on these expanding horizons of today's biology. A lot of exciting work seemed to take place in the comfortable intellectual 'confines' of our historical ways of thinking (e.g. the quantitative genetics of the 'Modern Synthesis' of the first half of the 20th century; Mayr 1982) or within the knowledge-spheres on particular groupings of birds and habitats. The latter leads to questions like: are 'landbirds' principally different from waterfowl, seabirds or shorebirds in the drivers of their habitat selection and development of their migration? Of course, seeking a larger perspective is far from easy, it requires time and serious effort to explore beyond one's own intellectual subfield. But without attempts to reach out to the rest of ornithology, and indeed biology, we miss out on great opportunities to learn from each other and contribute to science at large.

The recent history of ornithology (Birkhead *et al.* 2014) is packed with examples of studies on birds that contributed in major ways to the development of general biology (and palaeontology). Let me just list some examples: Darwin's finches played major roles in the thinking about phenotypic evolution from the early days (of Darwin himself) to the recent days (with the classic studies by Peter and Rosemary Grant and their many associates). Studies of speciation grew and thrived under the intellectual leadership of Ernst Mayr and continued through to Trevor Price, likewise both ornithologists. Modern population biology was more or less the making of students of birds, with David Lack and Ian Newton in the saddle in this case. Bird people took the study of hormones into the field (John Wingfield's leadership over many decades) and two bird people, John Krebs and Nick Davies, built behavioural ecology. And, finally, bird biologists resurrected Darwin's evolutionary force of sexual selection (with Malte Anderson at centre stage).

All of this work fell comfortably within the confines of the 'Modern Synthesis', of which Mayr in many ways was the scribe. This gene-centred view of biology is now under serious criticism by scientists (none of which are bird people!) that consider the 'Modern Synthesis' to be an intellectual framework that is limiting further discovery in biology. What is now called the 'extended evolutionary synthesis' (Laland *et al.* 2015) admits that there are several more ways in which phenotypic traits are passed on from one generation to the next than 'simply' the genetic pathway (Jablonka & Lamb 2014). Such multiple inheritance pathways allow environment feedbacks to be transferred to subsequent generations. There is also the realization that organisms are not so much built according to developmental programmes (genetic blueprints), but that development represents 'construction' – the interplay between stored information and physical self-organized processes (Turner 2007; this book can be summarized in the paraphrase "organisms are designed not so much because particular genes have made them that way, but because environments and simple physical processes build them that way").

Another force that goes missing in the 'Modern Synthesis' is 'reciprocal causation', the principle that both in the development of individual organisms, as in the ways that they function in their environments, causal arrows are usually bidirectional. Wrens build hidden and insulated nests to maintain the heat and avoid detection by predators, but hidden insulated nests in turn determine the physiology, morphology and incubation behaviour of wrens. Or, in a more general example, evolved phenotypes are not just a function of their environments, environments may have changed in response to those evolved phenotypes.

These are all potential evolutionary mechanisms that I did not learn about in school. But I would certainly like to consider them when trying to make sense of a world where rapid change (in environments, and in the shapes and behaviour of birds) increasingly seems to be the norm. The mechanisms emphasized by the extended evolutionary synthesis allow for a much greater 'creative' role of environments and for much faster evolution than the mechanisms 'allowed' by the 'Modern Synthesis'. I believe that we need scrutinize these possibilities if we want to make sense of the apparent great speed, for instance, with which shorebird flyway patterns have diversified (Piersma 2011, Conklin *et al.* 2016). In any case, it should be fun to be part of a big and heated debate (Wray *et al.* 2014 versus Laland *et al.* 2014).

This brings me back to Badajoz and my concern that as ornithologists we should seek greater exploration of the exciting new frontiers in biology. Embracing the fruits of the genomic revolution (e.g. Kraus & Wink 2015), we can now go back in measurable time (even quite recent time) and decipher degrees of relationships between individuals, populations and species and pin down some of the past selection pressures. At the same time, ornithologists in command of the ever greater range of individual tracking tools are in a fantastic position to bring studies on behavioural development, and the nitty-gritty details of the ways in which a population's ecological context shapes their spatial activity, reproductive success and survival, to bear on questions of rapid evolution. In the process, we not only learn about birds, but also contribute to fundamental understanding of phenotypic plasticity, inclusive inheritance and reciprocal causation (Laland *et al.* 2015). We may elucidate mechanisms that the flag-bearers of the extended evolutionary synthesis have yet to embrace. An example? As ornithologists we know a lot about seasonal carry-over effects, mechanisms that help generate individual variation and may increase adaptive capacity and 'evolvability' because they even out and thus dissipate the forces of some seasonally peaked selective pressures (Senner *et al.* 2015). Ornithologists are in a unique position to track the minute details of the entire lives of organisms that connect places and seasons, and should make the most of this to, once again, contribute to the forefront of biological thinking.

Birkhead T., Wimpenny J. & Montgomerie R. 2014. Ten thousand birds. Ornithology since Darwin. Princeton University Press, Princeton, NJ.

Conklin J.R., Reneerkens J., Verkuil Y.I., Tomkovich P.S., Palsbøll P.J. & Piersma T. 2016. Low genetic differentiation between Greenlandic and Siberian Sanderling populations implies a different phylogeographic history than found in Red Knots. J. Ornithol. 157: doi:10.1007/s10336-015-1284-4

Jablonka E. & Lamb M.J. 2014. Evolution in four dimensions. Genetic, epigenetic, behavioral, and symbolic variation in the history of life, revised edition. MIT Press, Cambridge, MA.

Kraus R.H.S. & Wink M. 2015. Avian genomics: fledging into the wild! J. Ornithol. 156: 851–865.

Laland K.N., Uller T., Feldman M.W., Sterelny K., Müller G.B., Moczek A., Jablonka E. & Odling-Smee J. 2014. Does evolutionary theory need a rethink? Yes, urgently. Nature 514: 161-164.

Laland K.N., Uller T., Feldman M.W., Sterelny K., Müller G.B., Moczek A., Jablonka E. & Odling-Smee J. 2015. The extended evolutionary synthesis: its structure, assumptions and predictions. Proc. R. Soc. B 228: 20151019.

Mayr E. 1982. The growth of biological thought: diversity, evolution and inheritance. Belknap Press, Cambridge, MA.

Piersma T. 2011. Flyway evolution is too fast to be explained by the modern synthesis: proposals for an 'extended' evolutionary research agenda. J. Ornithol. 152 (Suppl. 1): S151–S159.

Senner N.R., Conklin J.R. & Piersma T. 2015. An ontogenetic perspective on individual differences. Proc. R. Soc. B 282: 20151050.

Turner J.S. 2007. The tinkerer's accomplice. How design emerges from life itself. Harvard University Press, Cambridge, MA.

Wray G.A., Hoekstra H.E., Futuyma D.J., Lenski R.E., Mackay T.F.C., Schluter D. & Strassmann J.E. 2014. Does evolutionary theory need a rethink? No, all is well. Nature 514: 161-164.

Theunis Piersma